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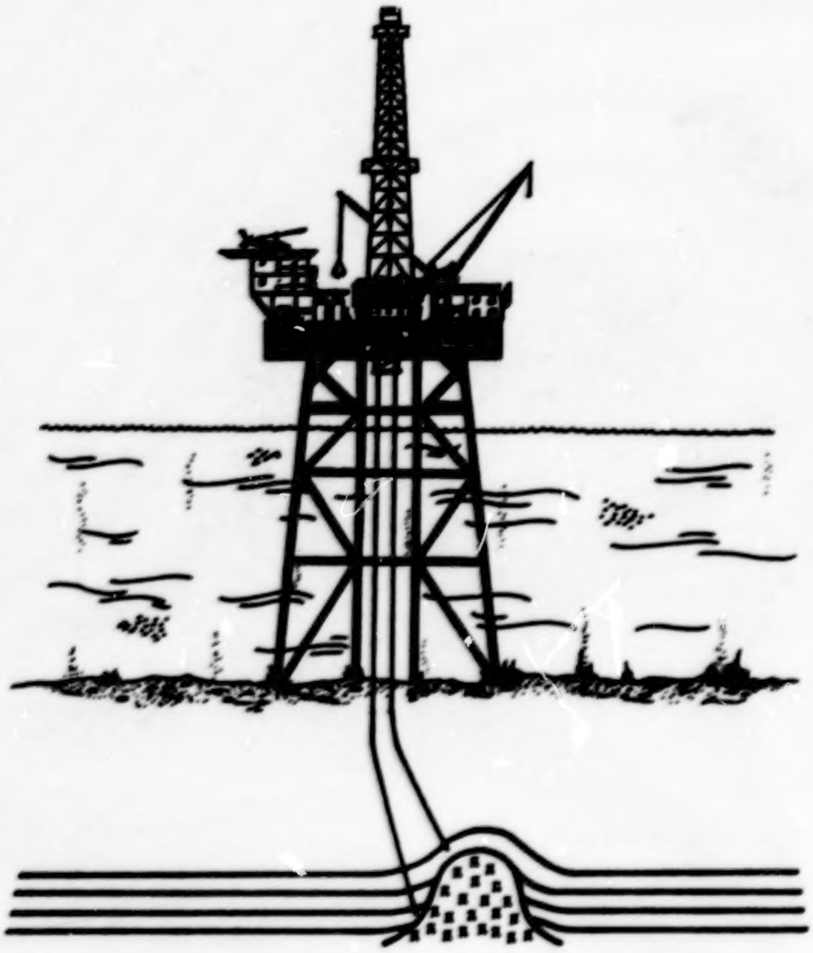
OCS Report
MMS 87-0070

Outer Continental Shelf

Estimated Oil and Gas Reserves, Gulf of Mexico, December 31, 1986



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U.S. Department of the Interior
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ORIGINAL

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Jack E. Hewitt
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U.S. Department of the Interior
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1987

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Estimated Oil and Gas Reserves

Gulf of Mexico Outer Continental Shelf

December 31, 1986

By Jack E. Hewitt, Jeff P. Brooke
James W. Compton, and John H. Knipmeyer

ABSTRACT

Remaining recoverable reserves of oil* and gas in the Gulf of Mexico Outer Continental Shelf (OCS) have been estimated to be 3.88 billion barrels of oil and 45.8 trillion cubic feet of gas, as of December 31, 1986. These reserves are recoverable from 613 studied fields located in Federal waters. For any field contained partly in State waters and partly in Federal waters, reserves are estimated for the Federal portion only. An additional 84 fields, discovered since December 31, 1984, have not been sufficiently developed to permit a reasonably accurate estimate of reserves.

Original recoverable reserves are estimated to have been 10.81 billion barrels of oil and 121.0 trillion cubic feet of gas from 645 fields in the same geographic area. Included in this number are 32 fields that are depleted and abandoned; not included are the 84 insufficiently developed fields. Estimates were made for individual reservoirs based on geologic mapping and reserve evaluation of 481 fields. Engineering studies were conducted for another 164 fields.

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* The term "oil" as used in this report includes crude oil and condensate.

INTRODUCTION

This report, which supersedes Minerals Management Service OCS Report MMS 86-0049 (Hewitt and others, 1986), presents estimates of original recoverable reserves, cumulative production, and estimates of remaining recoverable reserves as of December 31, 1986. The estimates of reserves for this report were completed in April 1987 and represent the combined efforts of engineers, geologists, paleontologists, and other personnel of the Minerals Management Service Gulf of Mexico OCS Regional Office in New Orleans, Louisiana.

As in previous reports (for example, Bryan and others, 1978), standard methods of estimating reserves were used, including volumetric calculation, decline curve analysis, material balance, and mathematical simulation.

DEFINITION OF RESERVE AND RESOURCE TERMS

The reserve and resource terminology in this report conforms with Dolton and others (1981, pp. 6-7). The quoted definitions of terms applicable to this report follow:

> "*Resources* — Concentrations of naturally occurring liquid or gaseous hydrocarbons in the Earth's crust, some part of which is currently or potentially economically extractable."
>
> "*Measured reserves* — That part of the economic identified resource that is estimated from geologic evidence supported directly by engineering measurements. Measured reserves here are equivalent to *proved reserves* as defined by API [American Petroleum Institute] (1976, p. 1)."
>
> "*Indicated reserves* — Reserves equivalent to API *indicated additional reserves*, that are defined as economic reserves in 'known productive reservoirs in existing fields expected to respond to improved recovery techniques such as fluid injection where (a) an improved recovery technique has been installed but its effect cannot yet be fully evaluated; or (b) an

improved technique has not been installed but knowledge of reservoir characteristics and the results of a known technique installed in a similar situation are available for use in the estimating procedure' (API, 1976, pp. 1, 2.)."

Other applicable definitions quoted from Miller and others (1975, pp. 8-9) follow:

"*Reserves* — That portion of the identified resource which can be economically extracted."

"*Demonstrated reserves* — A collective term for the sum of measured and indicated reserves."

Reserve figures presented in this report are demonstrated reserves as defined above.

Production data are the metered volumes of raw liquids and gas reported to the Minerals Management Service (MMS) by Federal lessees and operators. Oil volume measurements and reserves are corrected to reference standard conditions of 60°F and 14.696 psia (one atmosphere); gas measurements and reserves are corrected to 60°F and 15.025 psia. Continuously measured volumes from production platforms and/or leases are allocated to individual wells and reservoirs on the basis of periodic well test "gauges." These procedures introduce approximations in both production and reserves data by reservoirs, limiting accuracy to two or three significant figures.

RESERVES AND RELATED DATA REPORTED BY AREA

The Gulf of Mexico has been divided into three planning areas for administrative purposes. These planning areas (Western, Central, and Eastern) are shown in figures 1, 2, and 3, respectively. Each planning area is further divided into smaller areas, which in turn are divided into blocks. Fields in the Gulf of Mexico are identified by the smaller area name and block number of a discovery, for example, East Cameron Block 271 Field. As the field is developed, the limits often expand into adjacent blocks and areas. These adjacent blocks are then identified as being part of the original field and are given that field name. Statistics in this report are presented as area totals compiled under each field

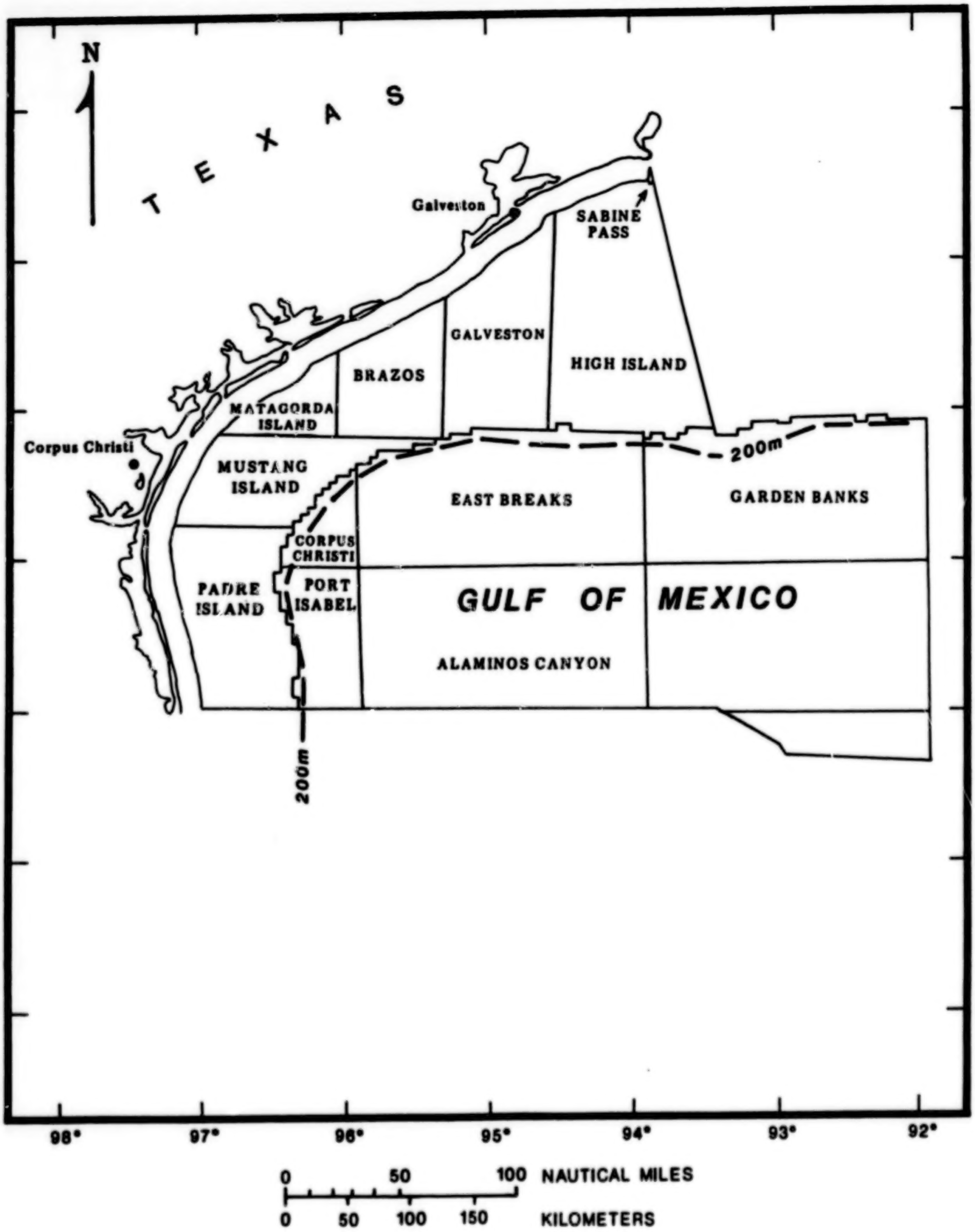

Figure 1. - Western Planning Area, Outer Continental Shelf. Dash line indicates 200-meter water depth.

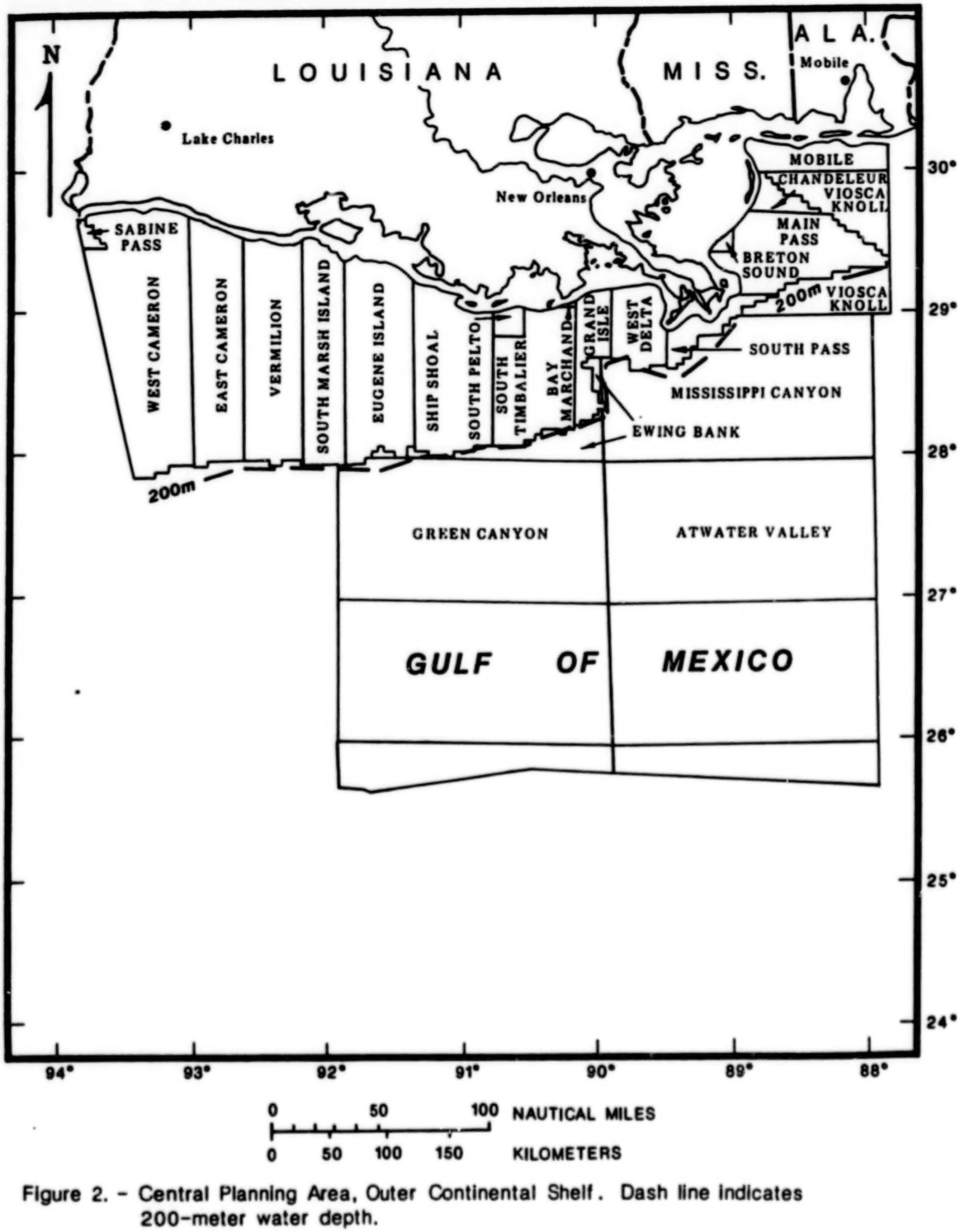

Figure 2. - Central Planning Area, Outer Continental Shelf. Dash line indicates 200-meter water depth.

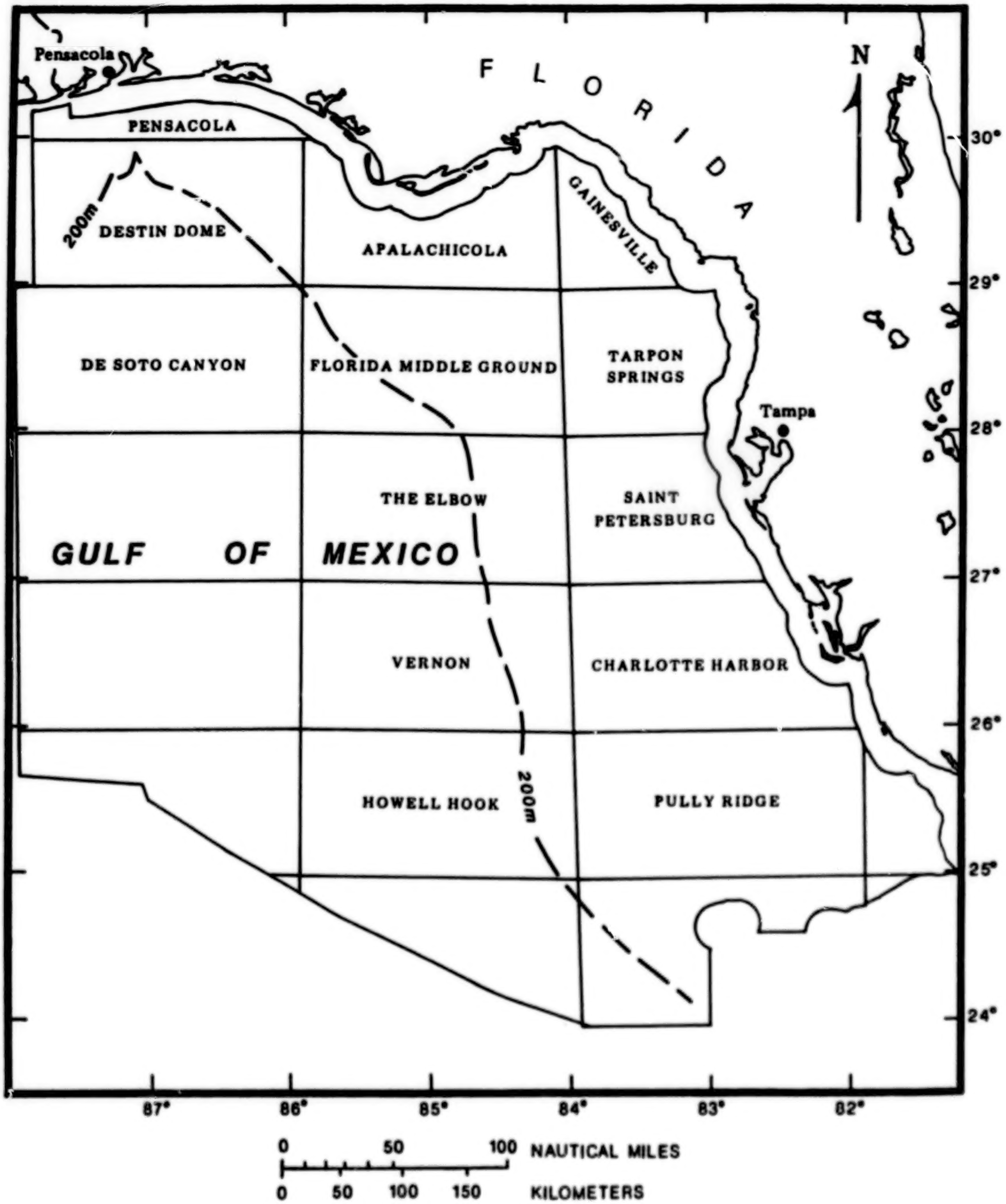

Figure 3. - Eastern Planning Area, Outer Continental Shelf. Dash line indicates 200-meter water depth.

name. All of the data associated with East Cameron Block 271 Field are therefore included in the East Cameron totals, even though part of the field extends into the adjacent area of Vermilion. There are four exceptions to the above field-naming techniques. These four fields and the area totals in which the field data are included are Tiger Shoal and Lighthouse Point, included in South Marsh Island; Coon Point, included in Ship Shoal; and Bay Marchand, included in South Timbalier.

On December 31, 1986, there were 697 active fields in the federally regulated part of the Gulf of Mexico, as listed by the MMS Gulf of Mexico Regional Field Names Committee. Of these, 613 were considered sufficiently developed to warrant estimation of reserves for this study. Another 84 were not sufficiently developed to permit a reasonably accurate estimate of reserves; therefore, no estimates have been attempted. In addition to the 613 active fields, 32 depleted fields (abandoned after production) are reported herein. This makes a total of 645 fields for which oil and gas reserves were estimated. The 32 depleted fields are not included in the Regional Field Names Committee's 697 active fields, but are reported here in order to give a complete record of cumulative oil and gas production.

Reserves data and various classifications of fields, leases, boreholes, and completions are presented as area totals in tables 1, 2, and 3. Estimates of demonstrated reserves for all producing fields, as well as all fields discovered before December 31, 1984, are presented as area totals in table 1. The 645 fields studied (613 active fields and 32 depleted fields) constitute the current listing in the MMS Outer Continental Shelf Information System (OCSIS). The 84 fields not sufficiently developed for study are not represented in the reserve data or in the OCSIS data processing system.

All Gulf of Mexico OCS Federal leases issued as of December 31, 1986, are represented in table 2. The 4,291 active leases and 2,535 relinquished leases are each classified into one of two main groups, studied and not studied. Further subgrouping and definitions of the groups are shown on page 10:

Table 1. — Estimated demonstrated oil and gas reserves for 645 fields by area, Gulf of Mexico Outer Continental Shelf, December 31, 1986

(Demonstrated reserves: oil expressed in millions of barrels, gas in billions of cubic feet.)

Area(s) (figs. 1, 2, and 3)	Number of fields: Studied		Number of fields: Not studied	Number of fields: Active with production	Original recoverable reserves		Cumulative production through 1986		Remaining recoverable reserves	
	Active	Depleted			Oil	Gas	Oil	Gas	Oil	Gas
Mustang Island and Padre Island	20	1	2	9	16	1,320	1	360	15	960
Matagorda Island	17	0	1	11	32	3,700	2	500	30	3,200
Brazos	18	3	1	15	10	2,150	4	850	6	1,300
Galveston	14	1	4	9	31	930	21	750	10	180
High Island and Sabine Pass	78	0	7	67	330	10,750	120	5,550	210	5,200
Western Slope*	7	0	3	3	46	770	0	0	46	770
Western Planning Area Subtotal	*154*	*5*	*18*	*114*	*465*	*19,620*	*148*	*8,010*	*317*	*11,610*
West Cameron and Sabine Pass	80	3	7	68	215	17,500	105	11,150	110	6,350
East Cameron	33	6	8	33	220	8,100	150	6,000	70	2,100
Vermilion	57	4	3	54	520	13,700	290	9,900	230	3,800
South Marsh Island	35	4	3	35	820	12,200	480	8,000	340	4,200
Eugene Island	56	3	2	50	1,520	15,200	910	10,000	610	5,200
Ship Shoal	45	3	7	41	1,270	10,000	810	7,100	460	2,900
South Timbalier	30	1	4	24	1,290	6,200	980	3,900	310	2,300
South Pelto	7	0	0	7	140	710	80	370	60	340
Grand Isle	14	1	0	11	920	3,820	730	2,900	190	920
West Delta	18	0	1	18	1,220	4,900	980	3,200	240	1,700
South Pass and Viosca Knoll	14	0	4	8	950	2,600	590	1,700	360	900
Main Pass and Breton Sound	34	2	5	26	860	3,900	530	2,400	330	1,500
Chandeleur and Mobile	9	0	6	3	0	900	0	100	0	800
Central Slope**	27	0	16	6	400	1,650	150	450	250	1,200
Central Planning Area Subtotal	*459*	*27*	*66*	*384*	*10,345*	*101,380*	*6,785*	*67,170*	*3,560*	*34,210*
*Eastern Planning Area Subtotal****	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Subtotal	*613*	*32*								
Total	***645***		***84***	***498***	***10,810***	***121,000***	***6,933***	***75,180***	***3,877***	***45,820***

*Western Slope includes Alaminos Canyon, Corpus Christi, East Breaks, Garden Banks, and Port Isabel.

**Central Slope includes Atwater Valley, Ewing Bank, Green Canyon, and Mississippi Canyon.

***Eastern Planning Area includes Charlotte Harbor, Destin Dome, Pensacola, Pulley Ridge, and others.

Table 2. — Status of leases, boreholes, and completions by area, Gulf of Mexico Outer Continental Shelf, December 31, 1986

Area(s) (figs. 1, 2, and 3)	Number of leases studied		Number of leases not studied			Number of boreholes		Number of active completions
	Active	Abandoned	Producible	Exploratory	Expired	Drilled	Abandoned	
Mustang Island and Padre Island	32	1	3	161	153	286	170	101
Matagorda Island	43	0	2	54	30	294	106	153
Brazos	31	3	1	56	86	315	165	129
Galveston	25	3	5	92	234	331	237	104
High Island and Sabine Pass	167	8	8	235	249	1,857	869	968
Western Slope*	14	0	3	338	34	169	105	53
Western Planning Area Subtotal ...	***312***	***15***	***22***	***936***	***786***	***3,252***	***1,652***	***1,508***
West Cameron and Sabine Pass	203	26	9	148	247	2,137	1,032	1,190
East Cameron	89	18	11	91	176	1,369	688	743
Vermilion	144	17	3	74	180	1,891	902	1,067
South Marsh Island	88	11	4	52	87	1,830	756	1,154
Eugene Island	174	29	3	85	144	3,156	1,420	1,938
Ship Shoal	130	13	7	88	133	2,431	1,095	1,616
South Timbalier	100	7	4	78	129	1,919	695	1,504
South Pelto	14	2	0	1	10	254	126	165
Grand Isle	52	7	0	16	45	1,029	529	731
West Delta	61	10	1	40	72	2,076	955	1,576
South Pass and Viosca Knoll	47	1	6	123	66	1,455	618	945
Main Pass and Breton Sound	93	11	6	101	118	1,594	602	1,236
Chandeleur and Mobile	16	0	6	75	6	58	21	19
Central Slope**	55	0	17	461	45	512	320	177
Central Planning Area Subtotal	***1,266***	***152***	***77***	***1,433***	***1,458***	***21,711***	***9,759***	***14,061***
Eastern Planning Area Subtotal ..***	***0***	***0***	***0***	***245***	***124***	***34***	***33***	***0***
Total	***1,578***	***167***	***99***	***2,614***	***2,368***	***24,997***	***11,444***	***15,569***

*Western Slope includes Alaminos Canyon,Corpus Christi, East Breaks, Garden Banks, and Port Isabel.

**Central Slope includes Atwater Valley, Ewing Bank, Green Canyon, and Mississippi Canyon.

***Eastern Planning Area includes Charlotte Harbor, Destin Dome, Pensacola, Pulley Ridge, and others.

Table 3. — Estimated demonstrated oil and gas reserves for 645 fields by geologic age, Gulf of Mexico Outer Continental Shelf, December 31, 1986

(Demonstrated reserves: oil expressed in millions of barrels, gas in billions of cubic feet.)

Geologic Age	Original recoverable reserves		Cumulative production through 1986		Remaining recoverable reserves	
	Oil	Gas	Oil	Gas	Oil	Gas
Western Planning Area						
Pleistocene	350	8,960	105	4,100	245	4,860
Pliocene	0	140	0	60	0	80
Upper Miocene	15	560	3	300	12	260
Middle Miocene	50	5,630	30	2,770	20	2,860
Lower Miocene	50	4,330	10	780	40	3,550
Other*	0	0	0	0	0	0
Western Planning Area Subtotal	***465***	***19,620***	***148***	***8,010***	***317***	***11,610***
Central Planning Area						
Pleistocene	3,530	39,090	2,030	25,890	1,500	13,200
Pliocene	3,170	17,880	2,190	11,820	980	6,060
Upper Miocene	3,000	22,680	2,172	15,400	828	7,280
Middle Miocene	570	17,070	360	11,930	210	5,140
Lower Miocene	70	3,270	30	1,790	40	1,480
Other*	5	1,390	3	340	2	1,050
Central Planning Area Subtotal	***10,345***	***101,380***	***6,785***	***67,170***	***3,560***	***34,210***
Eastern Planning Area Subtotal	***0***	***0***	***0***	***0***	***0***	***0***
Total	***10,810***	***121,000***	***6,933***	***75,180***	***3,877***	***45,820***

*Combined data of Jurassic and Cretaceous Systems and Oligocene Series.

Studied Active — Active leases designated within the 613 active studied fields presented in table 1.

Studied Abandoned — Leases relinquished after oil or gas production. The leases associated with the 32 depleted fields are represented here along with other produced, relinquished leases that were once part of fields still active. Expired leases without oil or gas production are classified as "Not Studied Expired" even though they were once part of a studied field.

Not Studied Producible — Leases associated with the 84 fields insufficiently developed for study. The leases have qualified as producible under OCS Order No. 4, Determination of Well Producibility (U.S. Department of the Interior, 1980), but have not established continuous production.

Not Studied Exploratory — Active leases not yet qualified as producible or associated with any field.

Not Studied Expired — Leases relinquished by the operator without having produced any oil or gas, even though some were once qualified producible under OCS Order No. 4, Determination of Well Producibility.

Also shown in table 2 are the total number of boreholes drilled and the number of those boreholes that have been plugged and abandoned in accordance with OCS Order No. 3, Plugging and Abandonment of Wells (U.S. Department of the Interior, 1980). Because of different criteria used this year for the classification of boreholes, many sidetracks are now counted as separate boreholes. Therefore, an accurate assessment of 1986 drilling activity cannot be obtained by comparisons with the borehole counts as of December 31, 1985. There were 659 boreholes spudded during 1986 as compared to 1,117 during 1985. The last column of table 2 presents the total number of active completions per area. Active completions are defined as those with perforations open to the formation and not isolated by permanent plugs; service wells (injection, disposal, or water source) are included. The presence or absence of production or injection is not considered. The number of boreholes and the number of active completions as of December 31, 1986, are based on reports received by MMS at the time the count was made in January. These numbers may change when all data for 1986 have been received and processed.

The reserves and production data of the 613 active fields and the 32 depleted fields have been classified by geologic age and are presented in table 3. Age determinations were made by paleontological examinations of borehole cuttings where feasible. In areas with limited paleontological information, geologic ages were extrapolated from adjacent blocks with biostratigraphic control. The generalized locations of the three major trends (Miocene, Pliocene, and Pleistocene) are shown in figure 4. Overlapping of adjacent trends occurs to varying degrees but has not been presented. Reserves data for the Jurassic and Cretaceous Systems and the Oligocene Series are combined and presented in table 3 as "Other."

STUDIES CONDUCTED

Geologic mapping and reserve evaluation were performed for 481 of the 645 fields, resulting in studies of approximately 16,000 individual reservoirs. Engineering studies were conducted for another 164 fields containing an additional 1,800 reservoirs. A volumetric estimate was made for each reservoir, and at least one other estimation method (for example, decline curve analysis) was used for many of the reservoirs. The subsequent performances of the reservoirs are periodically compared to the original predictions, and revisions to these predictions are made as needed.

Each abandoned field that had production has been assigned a value for original recoverable hydrocarbons equal to the amount actually produced.

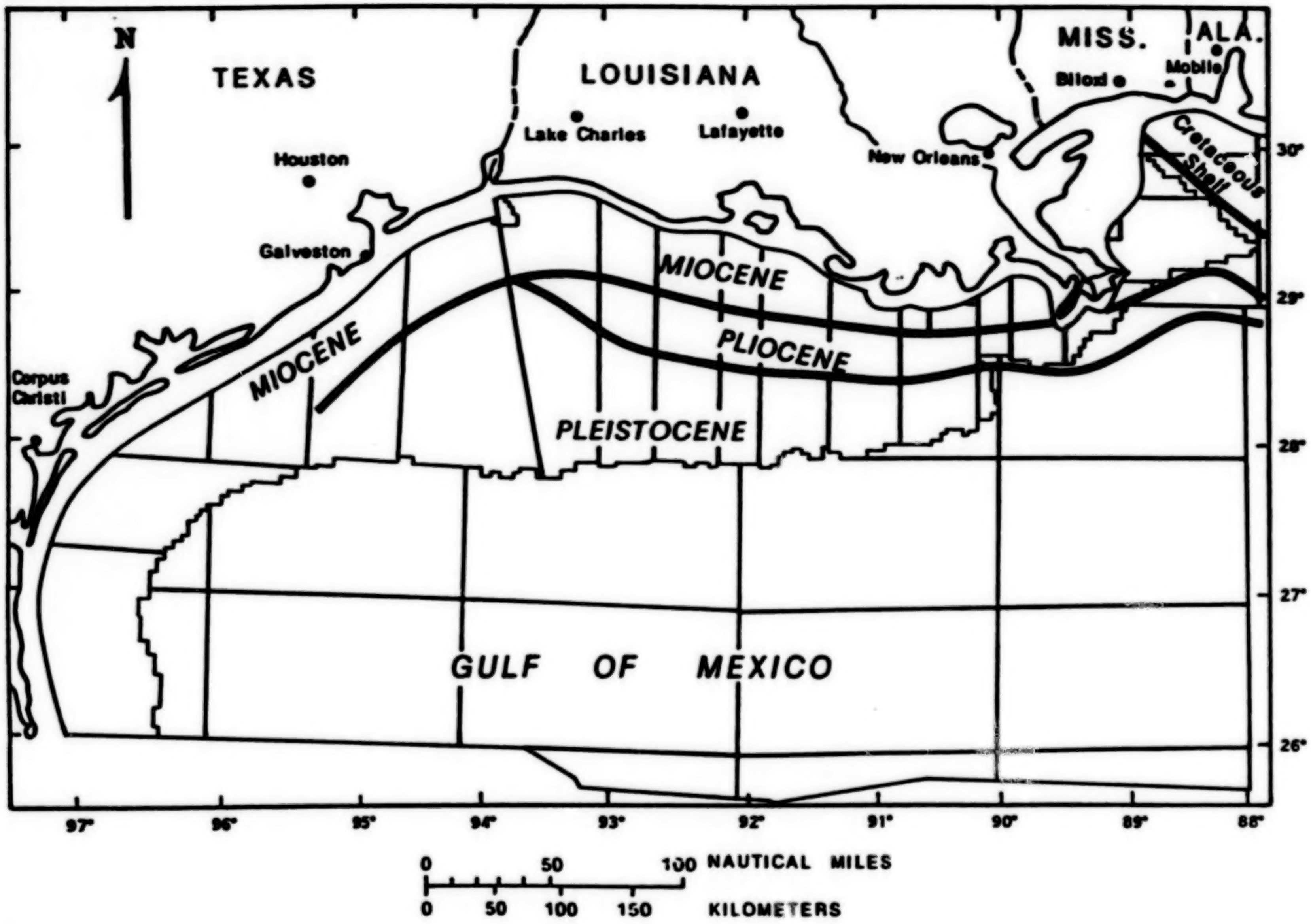

Figure 4. — Major production trends by geologic age, Western Planning Area and Central Planning Area. Trend lines terminate on the basis of known reserves.

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FIELD-SIZE DISTRIBUTION

The distribution of the various sizes of recoverable field reserves is shown in figures 5, 6, and 7. Figure 5 shows the field-size distribution of the original recoverable oil reserves for the 136 fields primarily producing oil, and figure 6 shows the field-size distribution of original recoverable gas reserves for the 509 fields primarily producing gas. Figure 7 shows the field-size distribution of the total original recoverable hydrocarbon reserves for the 645 fields included in this report. A geometric progression was selected for the horizontal scales in consideration of the log-normal type of distribution.

The oil field median size (exceeded by 50 percent of the fields) is 27 million barrels of oil and the mean (average) is 63 million barrels of oil. The petroleum industry commonly rates oil fields having original recoverable reserves of 100 million barrels or more as "major oil fields." Of the oil fields considered in this report, 27 contained 100 million barrels or more, accounting for 66 percent of the total original recoverable reserves contained in the 136 fields. Among the 509 gas fields (fig. 6), the median is 68 billion cubic feet of gas, and the mean is 186 billion cubic feet of gas. The largest three ranges, representing 50 gas fields, contained 52 percent of the total recoverable gas reserves.

Figure 7 shows the field-size distribution of the original recoverable hydrocarbon reserves of all 645 fields. For convenience of comparison, gas reserves are expressed in terms of barrels of oil equivalent (BOE) and added to the liquid reserves expressed in barrels. Based on the heating values of average Gulf of Mexico OCS hydrocarbons, the conversion factor used was 5,400 standard cubic feet of gas equals one BOE. The median field reserve is 17 million BOE, and the mean is 52 million BOE. The largest 59 fields contained 50 percent of the total recoverable hydrocarbon reserves.

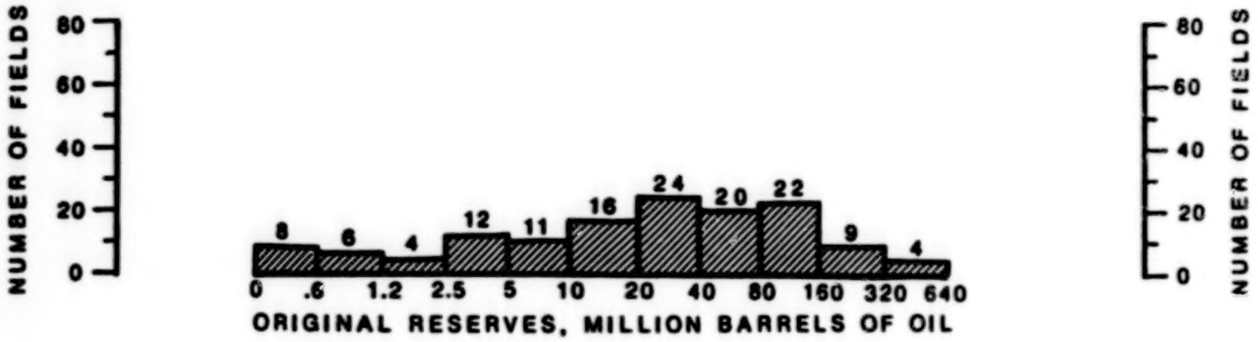

Figure 5. – Field-size distribution, 136 oil fields.

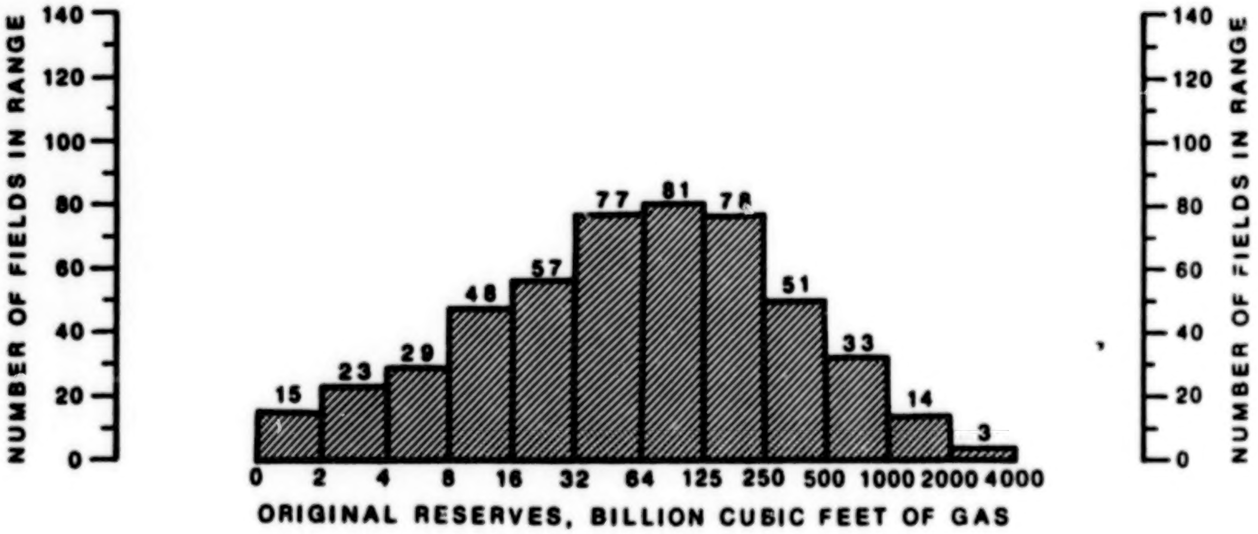

Figure 6. – Field-size distribution, 509 gas fields.

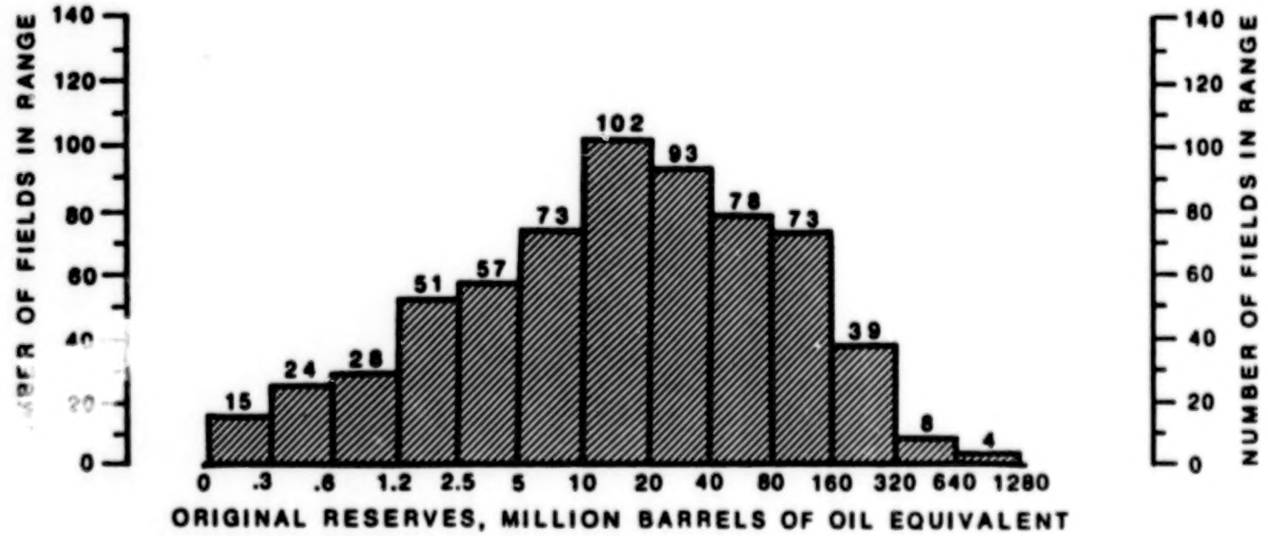

Figure 7. – Field-size distribution, 645 fields.

RESERVOIR-SIZE DISTRIBUTION

The distribution of the various sizes of the studied reservoirs is shown in figures 8 and 9. The size ranges, which are based on original hydrocarbons in place, are presented on the logarithmic, horizontal scale. The number of reservoirs in each size grouping, shown as percentages of the total, is presented on the linear, vertical scale. Combination reservoirs (saturated oil rims with associated gas caps) and reservoirs for which complete data are not available are excluded.

Figure 8 shows the reservoir-size distribution, based on original oil in place, for 5,072 studied oil reservoirs. The median is 0.8 million stock tank barrels of oil and the mean is 2.3 million stock tank barrels. Figure 9 shows the reservoir-size distribution, based on original gas in place, of 6,890 studied nonassociated gas reservoirs. The median is 4.4 billion standard cubic feet of gas and the mean is 15.0 billion standard cubic feet.

PRODUCTION RATES AND DISCOVERY TRENDS

The average daily production during 1986 was 874 thousand barrels of crude oil, 100 thousand barrels of gas condensate, 1.52 billion cubic feet of casinghead gas, and 9.56 billion cubic feet of gas-well gas. The average gas/oil ratio of oil wells was 1.74 thousand cubic feet per barrel, and the average condensate yield from gas wells was 10.43 barrels per million cubic feet.

Figures 10 and 11 show monthly production-rate frequency distribution by completion as reported for the month of October 1986. October production was selected for this study because the monthly production of 26,300 thousand barrels of crude oil and 282 billion cubic feet of gas-well gas most nearly matched the 1986 average monthly rates. Various production-rate ranges are shown on the logarithmic, horizontal scale, and the number of completions producing in that range is shown on the linear, vertical scale. To minimize the effect of test production, completions reported as having less

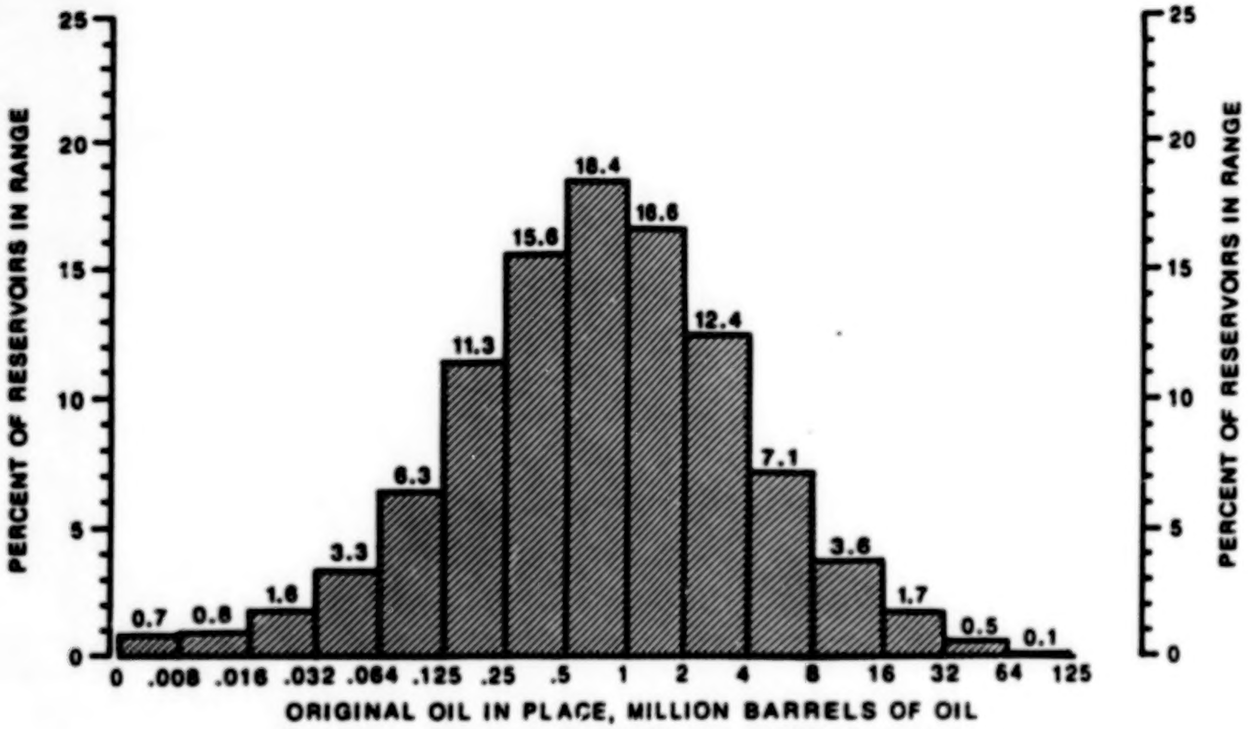

Figure 8. — Reservoir-size distribution, 5,072 oil reservoirs.

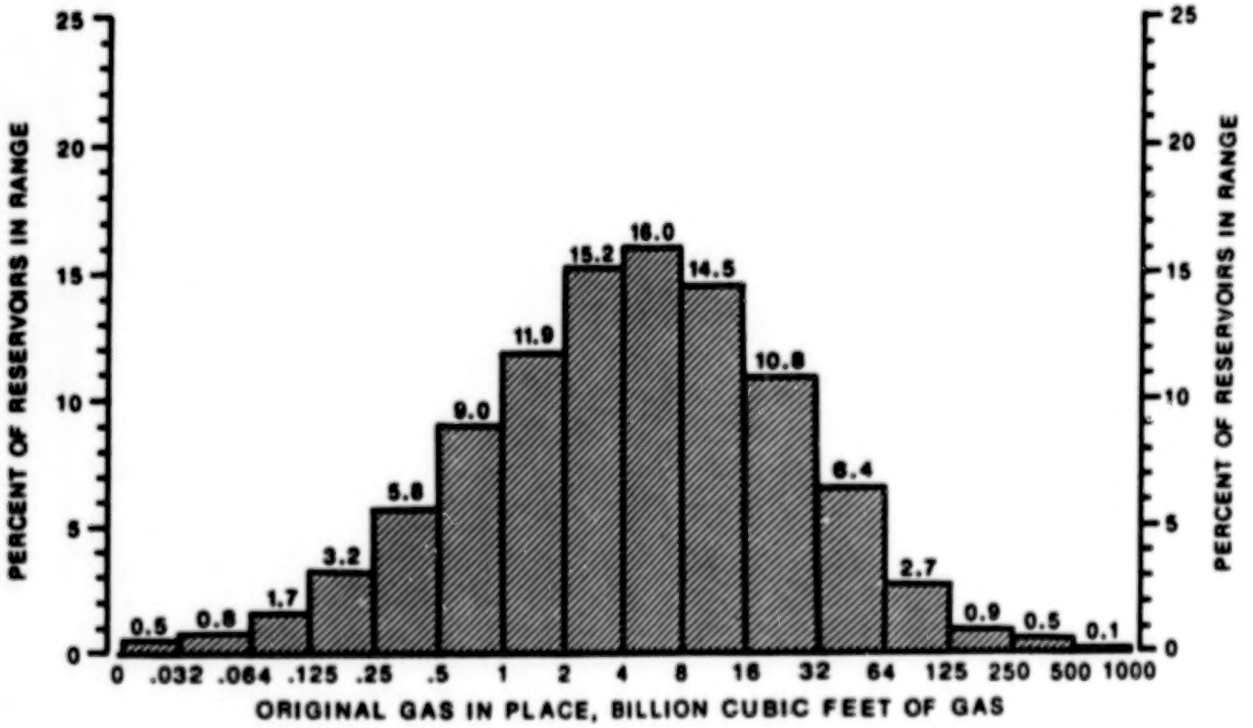

Figure 9. — Reservoir-size distribution, 6,890 gas reservoirs.

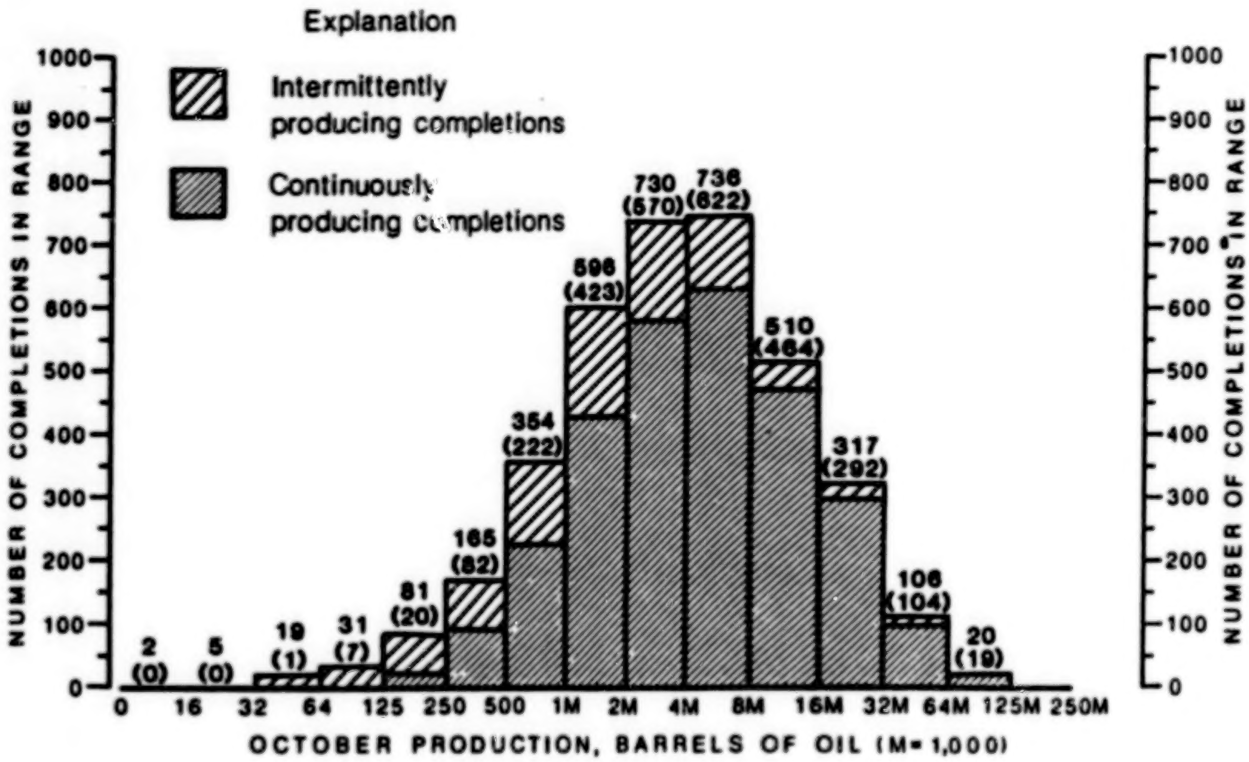

Figure 10. — Monthly production distribution, 3,672 oil completions, (2,826) continuously producing completions.

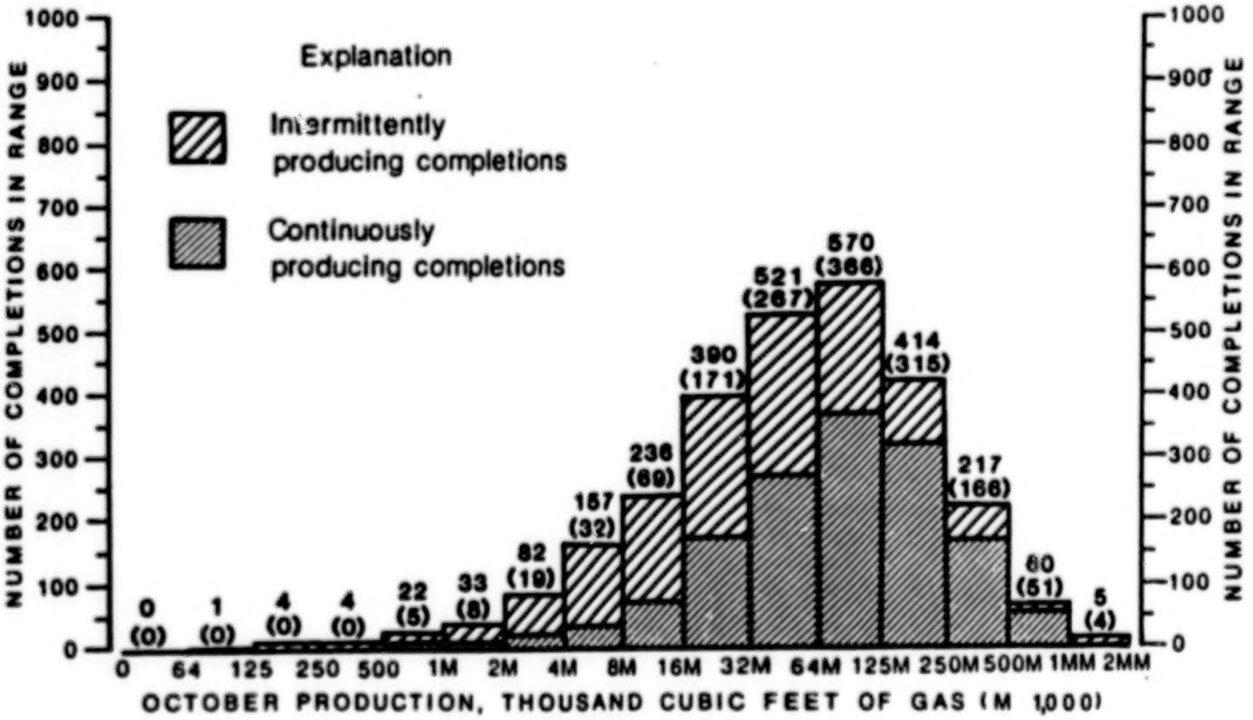

Figure 11. — Monthly production distribution, 2,716 gas completions, (1,473) continuously producing completions.

than 3 days of production during the month were excluded. For each grouping of production rates, two numbers are presented. The larger number represents the number of producing completions in that group and the smaller number, shown in parentheses, represents the number of continuously producing completions.

Figure 10 shows the distribution of the 3,672 oil completions producing more than 2 days during October. The median production rate is 3,555 barrels of oil per month, and the mean is 7,180 barrels per month. The analysis confirms 2,826 oil completions on continuous production during October and 131 completions averaging more than 1,000 barrels per day of crude oil production. Figure 11 shows the rate distribution of the 2,716 gas completions producing more than 2 days. The median production rate is 57.2 million cubic feet per month, and the mean is 103.8 million cubic feet per month. The study identifies 1,473 gas completions on continuous production during October with 195 completions averaging more than 10 million cubic feet per day of gas production.

Annual crude oil and nonassociated gas (gas-well gas) production since 1959 is shown in figure 12, with production volumes plotted on logarithmic scales. Crude oil production reached a peak of 0.34 billion barrels per year in 1971 and then began an 8-year decrease. Then in 1982 an increasing trend began. The 1986 annual crude oil production of 0.32 billion barrels is the highest since 1973. Annual gas-well gas production reached a peak of 4.5 trillion cubic feet in 1981. The 1986 gas-well gas production is 23 percent less than that of 1981 as the decreasing trend continues.

Figures 13 through 16 show oil and gas reserves and production data classified by discovery date. The year of discovery assigned to a field is the year in which the first well encountering significant hydrocarbons in that field was drilled. This date may differ from the year in which the field discovery was announced. The total field reserves, as currently estimated, are allocated to the year of discovery and combined for plotting. As a field develops, the total field reserves as originally estimated may subsequently change. Changes will be reflected by new totals at the field's discovery date. The annual

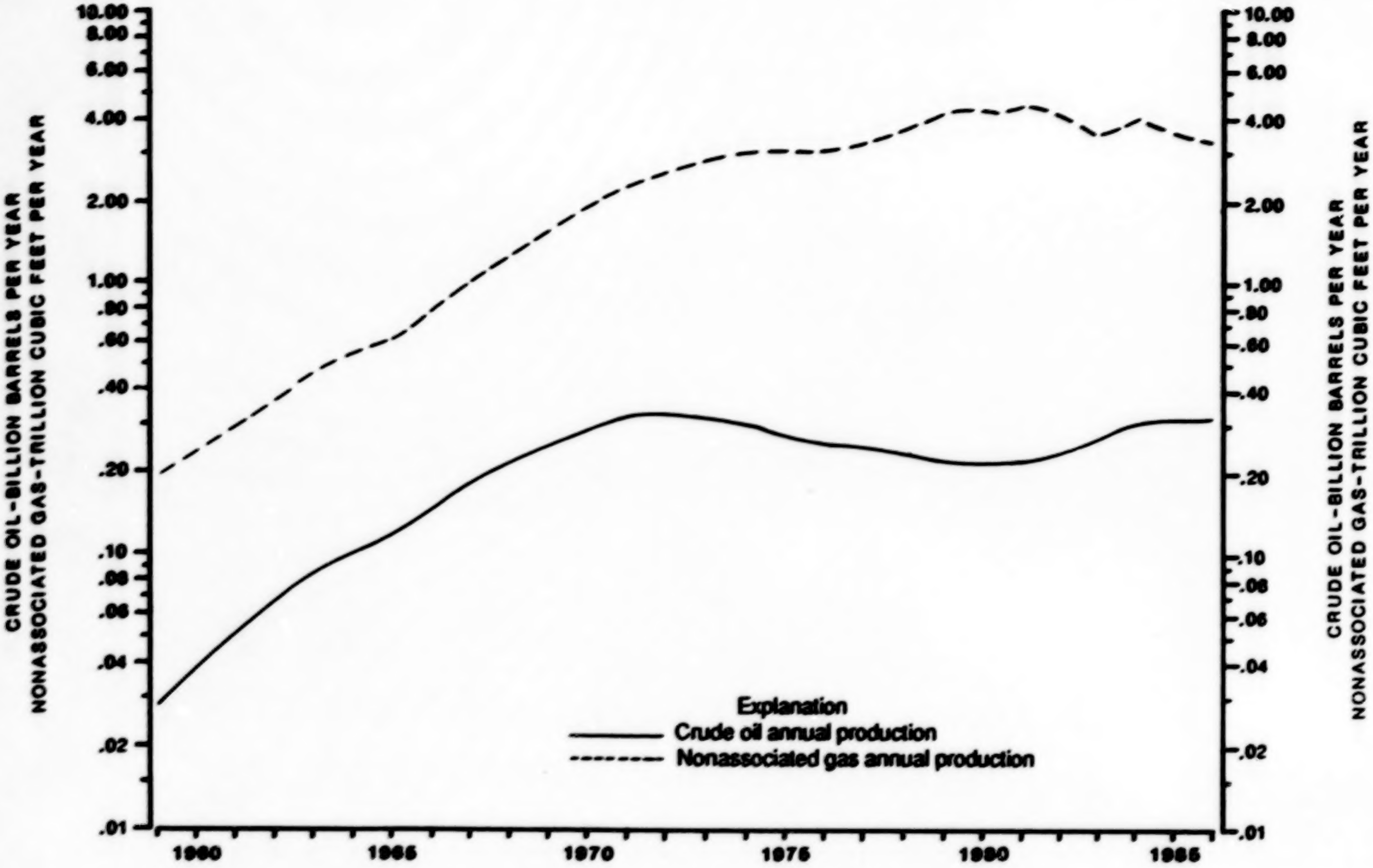

Figure 12. — Annual crude oil and nonassociated gas production.

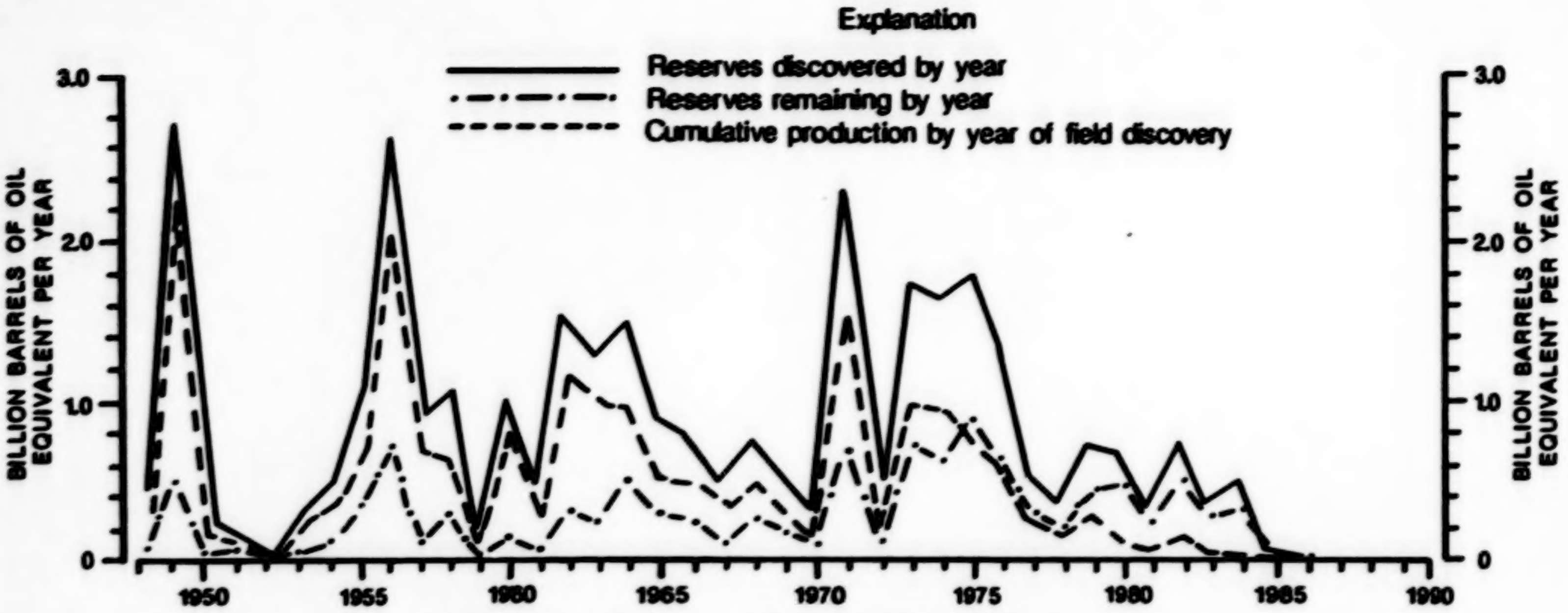

Figure 13. - Reserves and production by discovery year.

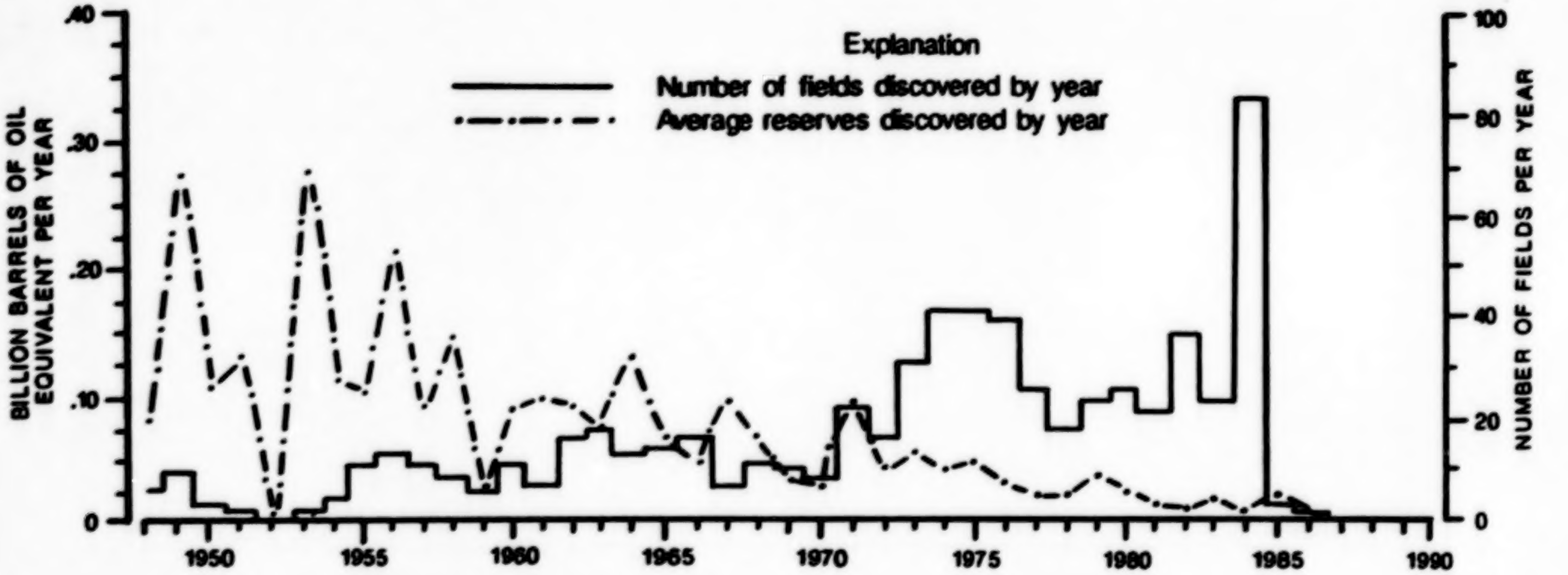

Figure 14. - Number of fields and average reserves by discovery year.

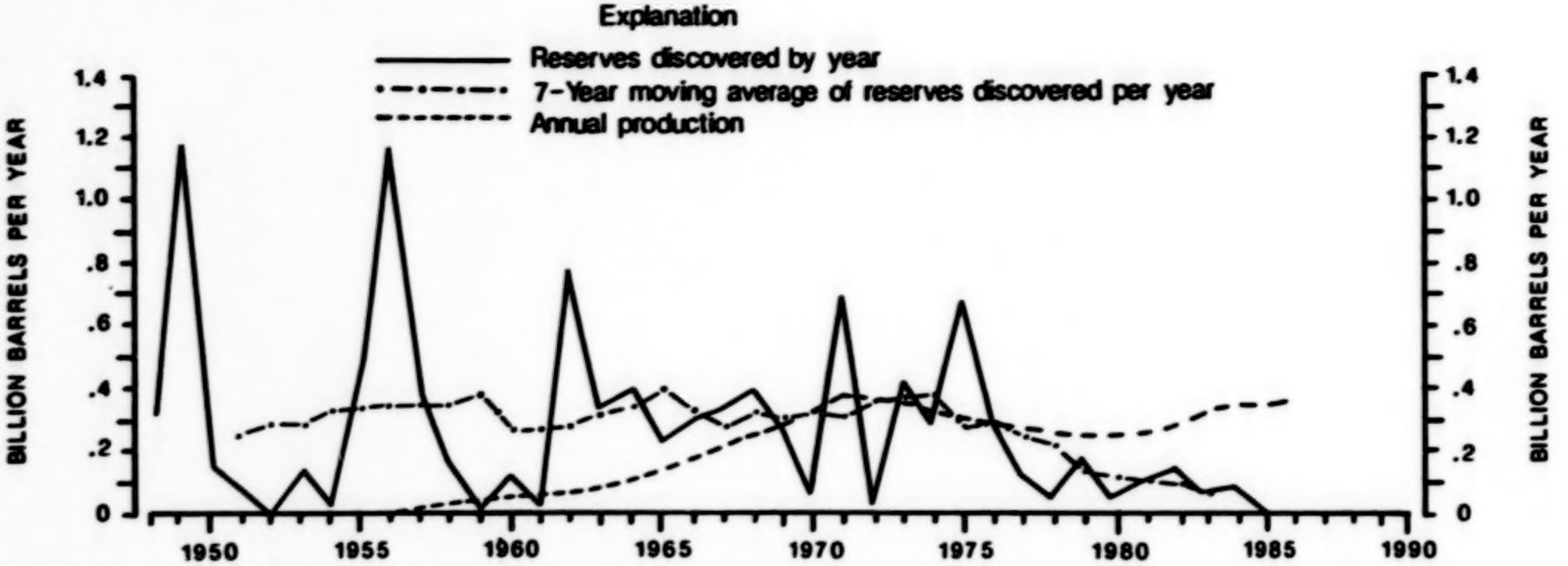

Figure 15. - Oil reserves discovered and oil production.

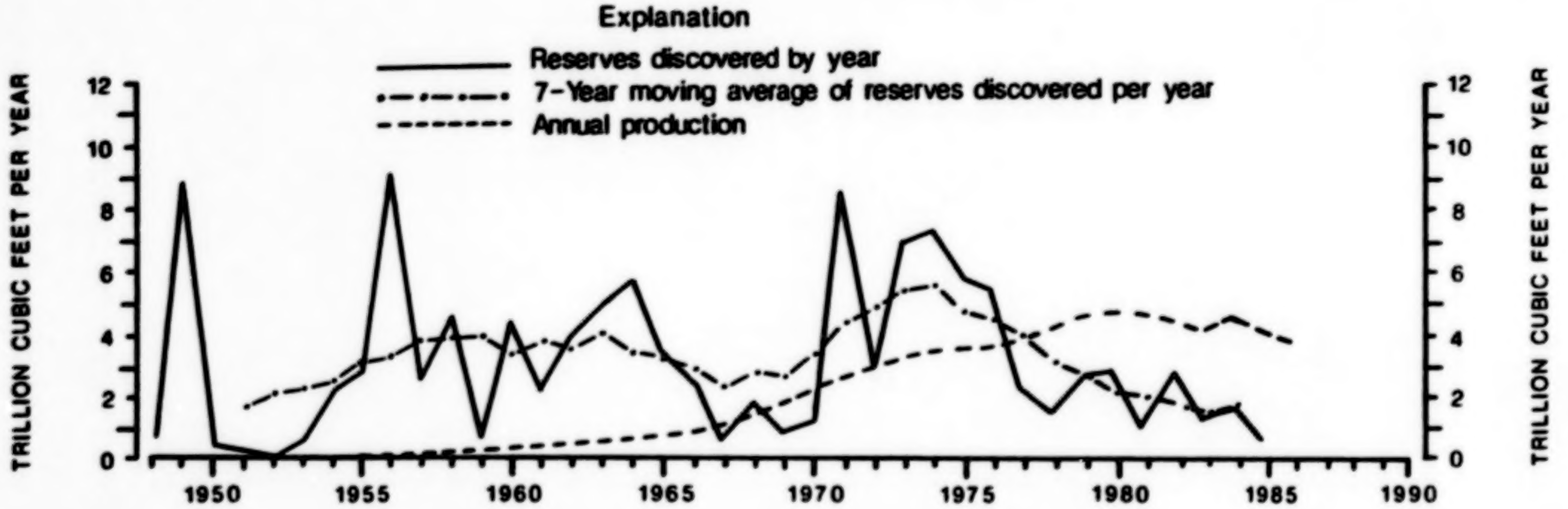

Figure 16. - Gas reserves discovered and gas production.

discovery curves of fields discovered before December 31, 1984, have been replotted to reflect new discoveries and annual revisions. Data for recent years are presented, but field development is insufficient to permit a lasting assessment of the reserves discovered in those years. Only those 1985 discoveries that have initiated production of oil or gas have been included.

Figure 13 presents reserves-discovered, cumulative production, and reserves-remaining in billion barrels of oil equivalent as of December 31, 1986, summed according to the year of field discovery. The degree of field depletion may be estimated by the relative positions of the cumulative production curves and the reserves-remaining curves. For example, if the value of the remaining reserves is higher than the value of cumulative production for a given year, the aggregate depletion for fields discovered that year is less than 50 percent. The plot demonstrates that fields discovered after 1975 are less than 50 percent depleted.

Figure 14 presents the number of fields discovered each year and the average discovery size in barrels of oil equivalent of fields discovered each year. The plot demonstrates a trend toward decreasing average size of discoveries over the last 25 years.

Figures 15 and 16 show oil and gas reserves and annual production by discovery year. Superimposed on each plot of yearly discoveries is a line depicting the 7-year moving average, which better indicates the overall trend by smoothing out the peaks. The average presented is the total of the hydrocarbons discovered in a 7-year period divided by seven and plotted for each middle year. For comparison with the rate of discoveries, the annual production of oil and gas is also shown. The annual oil production (fig. 15) has equaled or exceeded the 7-year moving average of discoveries every year since 1969 except 1974. The annual gas production (fig. 16) exceeded the 7-year moving average of gas discoveries for the first time in 1977.

All data presented in figures 13 and 14 combine crude oil, condensate, associated and nonassociated gas. All data presented in figure 15 include crude oil and condensate, and all data presented in figure 16 include associated and nonassociated gas.

SUMMARY

A summary of reserve estimate changes during the year and comparisons with the estimates as of December 31, 1985, are shown in table 4. The increase of original recoverable reserves resulting from new field discoveries (16 oil fields and 63 gas fields) is summarized and tabulated as changes to original recoverable reserves. The number of new discoveries added to the system during 1986 is the highest ever; however, the total volume of the reserves added because of new discoveries is the lowest in the last 4 years. Reserve estimates are revised as warranted, the estimates being increased as additional wells are drilled and new leases are added to existing fields, and the estimates being decreased as reservoirs are depleted and leases relinquished. Complete reevaluations of existing field studies are conducted as field development and production history indicate the need. These increases and decreases of reserve figures are summarized and presented as changes due to revisions.

Adjustments to cumulative production totals may be needed in reconciling balances between successive reports. These adjustments, shown in table 4, may become necessary because of rounding field data to significant figures or because of subsequent corrections of lease production reports.

Table 4 demonstrates that the 1986 oil discoveries and field revisions did not exceed oil production, resulting in a decrease of 0.17 billion barrels of oil reserves, but the 1986 gas discoveries and field revisions did exceed gas production by 0.2 trillion cubic feet.

Table 4. — Summary and comparison of oil and gas reserves as of December 31, 1985, and December 31, 1986

	Oil (billion bbls)		Gas (trillion cu ft)	
Original recoverable reserves:				
Previous estimates, as of 12/31/85 (Hewitt and others, 1986)		10.63		116.7
Discoveries	+0.08		+1.1	
Revisions	+0.11		+3.1	
Adjustments	-0.01		+0.1	
Net change		+0.18		+4.3
Estimate, as of 12/31/86 (this report)		10.81		121.0
Cumulative production:				
Through 1985 (Hewitt and others, 1986)		6.58		71.1
Adjustments		-0.01		+0.1
Through 1985 (corrected)		6.57		71.2
Production during 1986 (preliminary)		+0.36		+4.0
Through 1986 (this report)		6.93		75.2
Remaining recoverable reserves:				
Previous estimates, as of 12/31/85 (Hewitt and others, 1986)		4.05		45.6
Discoveries	+0.08		+1.1	
Revisions	+0.11		+3.1	
Adjustments	0.00		0.0	
Production during 1986 (preliminary)	-0.36		-4.0	
Net change		-0.17		+0.2
Estimate, as of 12/31/86 (this report)		3.88		45.8

CONCLUSIONS

The 645 oil and gas fields studied in the federally regulated part of the Gulf of Mexico originally contained reserves estimated at 10.81 billion barrels of oil and 121.0 trillion cubic feet of gas. Remaining recoverable reserves, as of December 31, 1986, are estimated to be 3.88 billion barrels of oil and 45.8 trillion cubic feet of gas. These figures represent a 4-percent decrease in estimated oil reserves and a 0.5-percent increase in gas reserves.

REFERENCES CITED

American Petroleum Institute, American Gas Association, and Canadian Petroleum Association, 1976, Reserves of crude oil, natural gas liquids, and natural gas in the United States and Canada as of December 31, 1975: Washington, D. C., American Petroleum Institute.

Bryan, F. T., Knipmeyer, J. H., and Schluntz, E. K., 1978, Estimated oil and gas reserves, Gulf of Mexico Outer Continental Shelf, January 1, 1977: U. S. Geological Survey Open-File Report 78-87, 11 p.

Dolton, G. M., and others, 1981, Estimates of undiscovered recoverable conventional resources of oil and gas in the United States: U. S. Geological Survey Circular 860, 87 p.

Hewitt, J. E., Brooke, J. P., Compton, J. W., and Knipmeyer, J. H., 1986, Estimated oil and gas reserves, Gulf of Mexico Outer Continental Shelf and Continental Slope, December 31, 1985: Minerals Management Service OCS Report MMS 86-0049, 25 p.

Miller, B. M., and others, 1975, Geological estimates of undiscovered recoverable oil and gas resources in the United States: U. S. Geological Survey Circular 725, 78 p.

U. S. Department of the Interior, Geological Survey, Conservation Division, 1980, Gulf of Mexico Outer Continental Shelf Order No. 3, Plugging and abandonment of wells, 6 p.: Reston, Va.

______, 1980, Gulf of Mexico Outer Continental Shelf Order No. 4, Determination of well producibility, 2 p.: Reston, Va.

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